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Association of Substance use and Gastrointestinal Cancers in an Indigenous People of Arunachal Pradesh

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Abstract: **Background**: The incidence of cancers affecting the gastrointestinal tract is increasingly recognised as a significant public health issue, especially among marginalised and indigenous communities. This investigation sought to evaluate the association between sociodemographic and lifestyle factors and the emergence of gastrointestinal cancers within the indigenous community of Arunachal Pradesh, India. **Methods**: A case-control study was carried out from January 2021 to April 2024 at TRIHMS, Naharlagun. This study comprises Two hundred thirty-two participants, in that 116 were cases of gastrointestinal cancer confirmed through histopathological examination and 116 matched controls without any malignancy, based on age and gender. Information regarding sociodemographic traits, patterns of substance use, and clinical profiles was gathered via structured interviews and medical documentation. The analysis of statistical data was conducted utilising SPSS version 26.0. An independent t-tests, Chi-square tests, and odds ratios (OR) accompanied by 95% confidence intervals (CI) were employed. A p-value <0.05 was considered as statistically significant outcome. **Results:** Findings indicate notable correlations between gastrointestinal cancers and reduced educational attainment ($p = 0.0001$), the consumption of local made fermented beverages (OR = 12.17, $p<0.0001$), tobacco usage (OR = 6.21, $p<0.0001$), and the intake of commercial alcohol (OR = 2.22, $p = 0.003$). The majority of cases were found within the age range of 35 to 71 and were located in urban settings. Gastric cancer emerged as the most frequently occurring type, accounting for 37.93%, while chemotherapy represented the predominant treatment approach, utilised in 81.89% of cases. A mere 7.7% cases showed positive family history for GIT cancer. **Conclusion**: The results reveal a strong association between traditional substance use, lower levels of education, and an increased risk of gastrointestinal cancers among indigenous populations. These trends are consistent with observations from other parts of Asia, underscoring the importance of implementing comprehensive cancer control strategies that prioritize education, early diagnosis, and culturally appropriate health promotion initiatives.

Key Words Substance use, Gastrointestinal cancers, Indigenous population, Arunachal Pradesh, Case-control study

INTRODUCTION

Gastrointestinal (GI) cancers, including malignancies of the oesophagus, stomach, and colon, represent a significant burden on global health, ranking among the top causes of cancer connected morbidity and mortality globally. According to GLOBOCAN 2020 data, GI cancers accounted for over 25% of global cancer deaths, with a disproportionately high prevalence in Asia, especially in middle to low-income regions where diagnosis is often delayed and access to healthcare is limited [1]. The incidence of GIT cancers in India was escalating with alarming concerns upon their prevalence in the Northeastern region, including the state of Arunachal Pradesh [2].

Arunachal Pradesh, located in the eastern Himalayan foothills, is home to a large number of indigenous tribal populations with distinct dietary habits, cultural practices, and lifestyle behaviors. The traditional consumption of fermented foods and beverages, use of smokeless tobacco, and limited access to preventive healthcare create a unique environment for assessing cancer risk. Despite anecdotal clinical observations of increasing GI cancer cases in this region, epidemiological data remain scarce. Most existing

studies in India have focused on urban or semi-urban populations, leaving a significant knowledge gap regarding tribal health and cancer epidemiology in remote areas [3]. The higher incidence of tobacco consumption in the northeastern states of India has been linked to increased cancer rates, particularly among men. Common cancers include those affecting the lungs, oral cavity, oesophagus, and stomach. Alcohol consumption is also notably high among tribal populations, especially among the Tangsa, Tutsa, Singpho, and Khamti tribes [4]. As per Arunachal Pradesh Disease Burden Profile (1990-2016), alcohol, tobacco, and substance abuse have consistently remained major risk factors contributing to mortality and disability in the state [5].

Multiple environmental and lifestyle factors were involved in the disease profile of GI cancers, such as tobacco use, alcohol consumption, diet, and socioeconomic status. Traditional fermented beverages, often consumed daily in many tribal households, may contain carcinogenic compounds such as acetaldehyde and aflatoxins due to unregulated fermentation processes [6]. Similarly, high tobacco consumption rates in Northeast India, particularly in smokeless forms, have been consistently linked with esophageal and gastric cancers [7].

This study aims to investigate the relationship between sociodemographic characteristics, lifestyle behaviors particularly traditional substance intake and the occurrence of GI cancers among the indigenous population of Arunachal Pradesh. With reference to the above literature, this study was designed to assess the association of various forms of alcohol, and tobacco use with gastrointestinal cancers in tribal people of Arunachal Pradesh.

METHODS

This case control study was carried out in the Department of Anatomy in collaboration with the cancer care centre at Tomo Riba Institute of Health and Medical Sciences (TRIHMS), Naharlagun, Arunachal Pradesh, spanning from January 2021 to April 2024. The study included 232 participants, consisting of 116 cases with clinically and histopathologically confirmed gastrointestinal (GI) cancer and 116 age and gender matched control subjects with above 18 years of age who had no history of malignancy. The subjects comprised individuals identified with esophageal, gastric, and colorectal malignancies. Individuals aged 18 years and older, belonging to the indigenous tribes of Arunachal Pradesh, India, who have been clinically diagnosed and histopathologically confirmed with gastrointestinal cancer, and are currently undergoing chemotherapy, radiotherapy, or surgical intervention, and are willing to participate, were included in the study. TRIHMS is the only state hospital with 500 bedded capacity consists dedicated cancer care centre represent whole population of Arunachal Pradesh. Individuals who are not indigenous and have gastrointestinal cancers, along with other concurrent malignancies, those with incomplete medical records or unverified diagnoses, patients receiving treatment for other cancers, severely ill individuals unable to respond to questionnaires, and those unwilling to participate were excluded from the study. The study details were explained to all the participants and sufficient time was allocated to each participant to clarify their concerns upon the study. After that written Informed consent was obtained and Study protocol was recommended by the institutional ethic committee (No. TRIHMS/ETHICS/01/2019-20/8 dated Naharlagun the 29th October, 2021).

A proforma was used to gather data via in-person interviews, conducted following the acquisition of informed consent by the principal investigator u. Further details were obtained from the medical records. The study gathered comprehensive details encompassing sociodemographic factors such as age, gender, education level, marital status, residence (urban/rural), and occupation. Substance Use Profile including traditional fermented drink consumption, commercial alcohol use, traditional alcohol use, tobacco use and Smoking status (regular, irregular, non-smoker), clinical profile including type of GIT cancer, status of family history and type of therapeutic intervention.

The analysis of data was conducted utilising IBM SPSS Statistics version 26.0. Calculations were performed for demographic and baseline variables, including means, standard deviations, and percentages. The chi-square test (χ^2) is employed to assess the relationships between categorical variables. Independent t-test: A method utilised for comparing the means of continuous variables across different groups, specifically between cases and controls. Odds Ratio (OR) accompanied by a 95% confidence interval Confidence Interval (CI): A statistical measure used to assess the relationship between exposures and the risk of developing cancer. A p-value less than 0.05 was deemed to indicate statistical significance.

RESULTS

A total of 232 participants were included in the study, comprising 116 confirmed cases of gastrointestinal (GI) cancer and 116 age and gender matched control subjects. The male predominance was observed among cases (62.07%) compared to controls (48.23%). The association was statistically significant ($\chi^2 = 4.462$, $p = 0.035$), with an odds ratio (OR) of 1.753, suggesting that males had a 1.75 times higher likelihood of developing GI cancers in this cohort. The age group 35-53 years was more frequent among cases (46.55%) than controls (29.31%), while 72-90 years were underrepresented among cases (8.62%) but significantly higher among controls (37.06%). The age distribution showed a strong statistical difference ($\chi^2 = 26.950$, $p<0.000004$). Urban residents comprised 75.86% of cases and 68.10% of controls. Although urban predominance was seen among cases, the difference was not statistically significant ($\chi^2 = 2.485$, $p = 0.289$).

Participants with only primary education were more frequent among cases (56.89%) than controls (24.13%). Those with graduation or above were notably more in controls (38.80%) than cases (13.80%). The difference was

Table 1: Details of Substance Intake Among Study Participants

Dietary habits	Cases Frequency (%)	Controls Frequency (%)	Chi-square value	Odd. Ratio	t- test
Type of substance intake					
Traditional fermented drink	108 (93.10%)	61 (52.58%)	48.13	12.172	0.0001
Commercial alcohol	80 (68.96%)	58 (50%)	8.656	2.222	0.003
Traditional alcohol	72 (62.06%)	57 (49.13%)	3.929	1.694	0.047
Tobacco	103 (88.79%)	65 (56.03%)	31.158	6.217	0.0001
Smoking status					
Regular	68 (58.62%)	41 (35.34%)	35.731	-	0.0001
Irregular	-	29 (25%)			
No smoking	48 (41.38%)	46 (39.65%)			

Table 2: Details Of Disease Condition and Therapy.

Disease profile	Cases (n=116) Frequency (%)	Chi-square value	t- test
Type of cancer			
Oesophageal	40 (34.48%)	4.809	0.186
Stomach	44 (37.93%)		
Colorectal	32 (27.58%)		
Family history			
Maternal	09 (7.7%)	90.72	0.0001
Paternal	-		
No	107 (92.24%)		
Details of medication			
Chemotherapy	95 (81.89%)	73.76	0.0001
Radiotherapy	02 (1.72%)		
Both	11 (9.48%)		
Therapeutic intervention	08 (6.89%)		

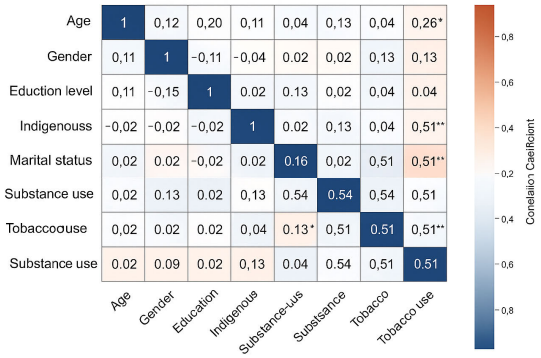

Figure 1: Correlation Matrix Illustrating the Relationships Between Demographic Factors and Substance Use and Tobacco Use

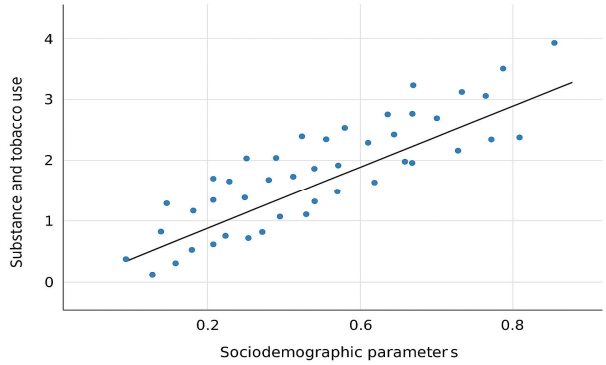

Figure 2: Regression Scatter Plot Showing the Positive Relationship Between Sociodemographic Variables and Substance Use and Tobacco Use

significant (χ^2 = 30.201, p<0.0001). A higher proportion of cases were in agriculture (39.65%) compared to controls (20.68%), while labour and unemployed categories were more prominent in controls. No statistically significant association was found (χ^2 = 3.434, p = 0.949).

A significantly higher proportion of cases (93.10%) reported the use of traditional fermented beverages compared to controls (52.58%). The chi-square value was 48.13, indicating a highly significant association (p<0.0001). The odds ratio (OR) = 12.172, suggesting that individuals consuming traditional fermented drinks had over 12 times greater odds of developing gastrointestinal cancer compared to non-consumers. Among the cases, 68.96% reported regular intake of commercial alcohol, compared to 50% of controls. A chi-square value of 8.656 and p = 0.003 indicated statistical significance. The OR = 2.222, indicating more than twice the odds of cancer development among alcohol consumers. Consumption of traditionally brewed alcohol (e.g., local spirits) was higher in cases (62.06%) compared to controls (49.13%). This difference was statistically significant (χ^2 = 3.929, p = 0.047, OR = 1.694). While the risk increase is more modest, these results are consistent with data from rural populations in Mongolia and Northern Vietnam, where unregulated alcohol fermentation processes may result in contamination with carcinogenic compounds (e.g., ethanol derivatives, mycotoxins). Tobacco and its different forms consumption was significantly elevated in the case group (88.79%) versus controls (56.03%), with a highly significant chi-square value of 31.158 (p<0.0001). The OR = 6.217, indicating a six-fold increase in risk (Table 1).

Among the 116 GI cancer patients, Gastric cancer had the highest prevalence (37.93%), followed by esophageal cancer (34.48%), and colorectal cancer (27.58%). The chi-square value of 4.809 and a t-test value of 0.186 indicate no statistically significant difference in the distribution of different types of GI cancers ($p>0.05$), suggesting a relatively even burden across these subtypes in the studied population. Only 7.7% of patients had a maternal family history of GI cancer. None reported paternal history, while 92.24% had no family history. A highly significant chi-square value (90.72) and t-test ($p = 0.0001$) indicate that lack of family history was a dominant characteristic among cases. This suggests that environmental and lifestyle risk factors likely played a larger role than hereditary predisposition in this population.

The majority of patients (81.89%) received chemotherapy as a primary treatment modality. Only a small fraction underwent radiotherapy (1.72%) or combined therapy (9.48%). About 6.89% received palliative interventions. The highly significant chi-square value (73.76) and t-test result ($p = 0.0001$) highlight a clear treatment pattern, with chemotherapy being the main therapeutic approach (Table 2).

The correlation matrix heatmap depicting relationships between demographic variables (age, gender, education level, indigenous status, marital status) and behavioral factors (substance use and tobacco use). The cells contain correlation coefficients, with colors ranging from blue (negative correlation) to red (positive correlation). Darker hues indicate stronger correlations, and asterisks mark statistically significant associations (*$p<0.05$, **$p<0.01$). Notable findings include positive correlations between marital status and both substance and tobacco use, as well as between substance use and tobacco use, while most other correlations are weak or near zero (Figure 1).

The regression scatterplot illustrates a positive association between aggregated sociodemographic parameters and substance/tobacco use, with data points showing an upward trend and a fitted regression line indicating that higher sociodemographic scores are generally linked to increased use (Figure 2).

DISCUSSION

This case-control study evaluated the association between sociodemographic characteristics, substance use, tobacco use and gastrointestinal (GI) cancers among the indigenous tribal population of Arunachal Pradesh, India. The results provide critical insights into the epidemiology of GI malignancies in this underserved region and align with broader trends observed in similar populations across India and Asia. A majority of cases (56.89%) had only primary education, in contrast to controls (24.13%). Our findings were similar to a study by Gupta *et al.* in North India, which reported an increased risk of upper GI cancers in individuals with limited formal education, likely due to poor health literacy, delayed health-seeking behavior, and limited awareness of risk factors [8].

Urban residency was more common among cases (75.86%) than controls (68.10%), though not statistically significant. While rural areas often show higher cancer risks due to environmental exposures and poor sanitation, urban settings in Northeast India may paradoxically expose individuals to increased risk due to greater access to tobacco, alcohol, and processed foods, a trend seen in rapidly urbanizing Asian regions such as Thailand and Vietnam [9]. The peak incidence of GI cancers was observed in individuals aged 35-71 years, which aligns with national data from the National Cancer Registry Programme (ICMR, 2020) showing higher GI cancer prevalence in middle-aged to old age people [10]. The male predominance observed (62.07% in cases) is supported by Indian and international literature, indicating that men have a higher risk of esophageal and gastric cancers, possibly due to higher rates of tobacco and alcohol use [11]. As per the Profile of Cancer and Related Health Indicators in the North East Region of India, ICMR-NCDIR, Bengaluru, the chances of developing GIT cancers were high among both genders compared to hepatic and oesophageal malignancies in males, malignancies to cervix and breast in females belongs to the West Arunachal and Pasighat regions of Arunachal Pradesh. Among cancer patients, 24.5% of males and 11.1% of females reported tobacco use, with esophageal cancer accounting for 7.7% in males and 3.9% in females. Overall, 29% of male and 10.9% of female cancer patients use tobacco, with esophageal and lung cancers being the leading types associated with tobacco use in males, and tobacco use also prevalent among female patients (12).

A key finding of our study was the strong association between the use of traditional fermented beverages and GI cancer (OR = 12.17, $p<0.0001$). These drinks, including locally brewed rice beer and apong, are widely consumed among tribal communities and may contain carcinogenic byproducts such as acetaldehyde, ethanol derivatives, and mycotoxins from improper fermentation. Similar concerns have been raised in studies conducted in Mongolia, Northern Vietnam, and rural China, where home-brewed alcohols were linked to higher esophageal and stomach cancer rates [12,13].

Tobacco use, both smokeless and smoked, was significantly higher in cases (88.79%) compared to controls (56.03%). The six-fold increased risk (OR = 6.21) observed in our study mirrors findings from Sankaranarayanan *et al.* who reported high odds for oral and upper GI cancers in tobacco users in Kerala and Tamil Nadu [14]. Tobacco use remains deeply embedded in tribal culture, often starting at an early age, and is compounded by poor regulation and lack of cessation programs in remote areas. According to the ICMR-NCDIR 2021 report, the cumulative tobacco consumption in Arunachal Pradesh was 45.5% (39.3% smokeless form and 22.7% smoked form) (12).

Commercial alcohol and traditional alcohol use also showed significant associations, supporting existing evidence from Sri Lanka, South Korea, and Eastern India, where habitual alcohol intake was linked to gastric and colorectal cancers [15, 16]. Ethanol, particularly when consumed

regularly, acts as a mucosal irritant and metabolic carcinogen via the CYP2E1 pathway, promoting mutations in the upper GI tract. According to the ICMR-NCDIR 2021 report, the prevalence of alcohol intake in indigenous people aged above 15 years was 59% in males and 26.3% in females. In urban areas, prevalence was 55.3% in males and 22.3% in females, while in rural areas it was 60.5% in males and 27.8% in females (12). alcohol consumption, tobacco smoking, and passive smoking, and are more prevalent in the Northeast India compared to national averages from countrywide surveys, a pattern that is contemplated in elevated cancer occurrence reported by the National Cancer Registry Programmes [17, 18].

Gastric cancer emerged as the most prevalent malignancy (37.93%) in our cohort, followed by esophageal and colorectal cancers. This distribution mirrors trends from the GLOBOCAN 2020 database, where gastric and esophageal cancers are disproportionately high in East and Northeast Indian populations, as well as bordering countries like China, Bhutan, and Nepal [19]. Dietary patterns rich in smoked meats, pickled vegetables, and nitrosamines prevalent in tribal cuisine may explain these patterns.

Interestingly, only 7.7% of participants had a maternal family history of GI cancers, and none reported paternal history. This aligns with the hypothesis that environmental and lifestyle exposures outweigh genetic predisposition in tribal regions. Similar findings were observed in studies among ethnic minorities in Yunnan Province, China, and in the Meghalaya and Nagaland states of India, where GI cancer risk was linked more to exposure profiles than to heritability [20-22]. Chemotherapy was the primary treatment modality in our study (81.89%), with limited access to radiotherapy or combined therapy. This may reflect infrastructural limitations and delayed diagnosis common in tribal and remote areas. The underutilization of radiotherapy is similar to reports from Manipur and Assam, where logistical barriers and referral delays restrict treatment options [23].

CONCLUSION

This study provides strong evidence of the association between traditional substance use, sociodemographic disadvantage, and GI cancer risk among the indigenous tribal population of Arunachal Pradesh. The findings mirror patterns in other Asian regions, reinforcing the need for comprehensive cancer control programs focused on education, early detection, and culturally sensitive health promotion.

Strength and Weakness

This study has notable strengths, being among the first to investigate gastrointestinal cancers in the indigenous tribal population of Arunachal Pradesh, thereby offering culturally relevant insights from an underrepresented region. The case–control design enabled the evaluation of multiple exposures, including traditional practices, sociodemographic factors, lifestyle habits, and substance use. Strong associations were identified for alcohol and tobacco consumption, consistent with existing evidence from similar populations.

Limitations

There may have been underreporting of exposures and family history, and important variables such as *Helicobacter pylori* infection, occupational factors, and micronutrient intake were not evaluated. Furthermore, all cases of esophageal, gastric, intestinal, and colorectal cancers were combined for genetic analysis without subtype categorization, which could limit the specificity of the findings.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Statement

The study protocol was approved by the institutional ethics committee of Tomo Riba Institute of Health and Medical Sciences (TRIHMS), Naharlagun (No. TRIHMS/ETHICS /01/2019-20/8 dated Naharlagun the 29th October, 2021).

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